USDA Forest Service
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Rocky Mountain Research Station

Science You Can Use *(in 5 minutes)*

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# Resources to Improve the Efficiencies of Forest Operations

As we increase the pace and scale of forest restoration, scientists and managers are leveraging a constellation of powerful new GIS and remote sensing technologies to improve the effectiveness and efficiency of forest operations. Two situations are particularly challenging and in need of innovative solutions. Compared to traditional timber sales, it is difficult to predict the location, volume, and delivered costs of the log and biomass supply flowing from fuel treatment and timber salvage operations across large landscapes. In fuel treatment and timber salvage operations, it is also difficult to integrate the capabilities of new logging systems into forest planning, especially when it comes to new equipment designed for steep slope operations. In both cases, defaulting to traditional techniques for supply chain management and harvest planning can result in sub-optimal outcomes that have greater uncertainty and higher costs.

To improve the efficiency and economics of fuel treatment and salvage operations, a team comprised of Nate Anderson and John Hogland, both research foresters with the USDA Rocky Mountain Research Station (RMRS), and researchers with the University of Idaho and Oregon State University created two new mapping tools. These tools are outputs of the Bioenergy Alliance Network of the Rockies (BANR), whose goal was creating a new bioeconomy to derive economic value from dead timber and biomass left in the wake of large-scale disturbances like beetle epidemics and wildfire.

## Biomass procurement and supply chain analysis tool

Because hauling lower value products to a sawmill or biomass facility may cost more than the products are worth, minimizing transportation costs can be critical to project viability. A GIS-based procurement add-in, developed by RMRS, allows managers to estimate the log and biomass volumes, harvest costs, and off-road and on-road transportation costs for any location on the landscape.

“One of the functions within this tool is a path-distance function that converts distances to travel times,” explains Hogland. “This path-distance function can be converted into dollars based on machine rates and per unit of volume out on the landscape.”

Because the machine rates and gate prices flucuate, the add-in is designed to allow users to input prices for their region. Also included in the add-in is the ability to spatially quantify standing and harvest volume by species group for a specified procurement area,

*Large-scale disturbances like beetle epidemics and wildfire often leave lower grade dead timber and biomass in their wake. Pictured here is a pile of salvaged lodgepole pine ready for loading in the Colorado State Forest. USDA photo Nate Anderson.*

given various user-defined inputs. For example, when estimating the volume from dead stands, managers can anticipate a 50 percent decrease in biomass compared to green timber biomass because of the loss of needles, tops, and bark.

## Harvest system mapping

Ryer Becker, a graduate student at the University of Idaho, developed a technique to map the suitability of different harvest systems to specific treatment units across large landscapes and created a harvest system map for a 74,000 acre study area of the Nez Perce Clearwater National Forest. The method combines lidar and ground plot inventory data with engineering information to facilitate the optimal deployment of harvest systems, including tethered and winch-assisted equpiment.

The value of this mapping, Anderson says, is that "we can now look at the forest from a planning perspective that is informed by forest operations and new technologies that are coming online. We can think about where certain types of harvesting activities make sense not just financially, but from an environmental efficiency standpoint in terms of minimizing negative impacts."

*Predictions of the log and biomass supply flowing from fuel treatment and timber salvage require accurate allometric equations based on intensive field data collection, conducted here by members of the BANR team. BANR photo by John Field.*

## FURTHER READING


Hogland, J.; Anderson, N.; Chung, W. 2018. New geospatial approaches for efficiently mapping forest biomass logistics at high resolution over large areas. ISPRS International Journal of Geo-Information. 7(4): 156.

Becker, R.M.; Keefe, R.F.; Anderson, N.M.; Eitel, J.U.H. 2018. Use of lidar derived landscape parameters to characterize alternative harvest system options in the Inland Northwest. International Journal of Forest Engineering. 29(3): 179–191.


## LEAD SCIENTISTS


**Nathaniel (Nate) Anderson** is a research forester with the RMRS in Missoula, Montana. His research is on forest management and blends silviculture, operations research, and economics.

**John Hogland** is a research forester with the RMRS in Missoula, Montana. John's research interests include developing new spatial modeling procedures that quickly process large amounts of data and integrating supply chain models with estimates of forest characteristics derived from high resolution imagery.


## Key Findings

- RMRS Raster Utility, a new GIS-based biomass procurement toolbar add-in developed by RMRS, allows managers to better calculate the volume of biomass in a given harvest area and determine the best harvest and wood procurement scenario.
- Using decision tools that integrate lidar-derived maps of the landscape with harvest system capabilities allows forest managers and contractors to select the harvest system that will maximize production and efficiency while minimizing environmental impacts.
- When harvesting biomass, selecting the harvest system most suitable to the landscape can reduce the overall cost of the treatment. Additionally, improving transportation efficiencies through the mapping of transportation routes in the GIS-based biomass procurement add-in can reduce transportation costs.

**The Rocky Mountain Research Station is one of seven units within USDA Forest Service Research & Development. RMRS maintains 14 field laboratories throughout a 12-state geography encompassing parts of the Great Basin, Southwest, Rocky Mountains, and the Great Plains. While anchored in the geography of the West, our research is global in scale. RMRS also administers and conducts research on 14 experimental forests, ranges and watersheds and maintains long-term research databases for these areas. Our science improves lives and landscapes. More information about Forest Service research in the Rocky Mountain Region can be found here: https://www.fs.usda.gov/rmrs/.**